INVESTIGATIONS OF THE ECOLOGY AND CONTROL OF SPIDER MITES IN COTTON.

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Three species of pest mites are found in cotton in NSW and Qld: the two spotted mite, *Tetranychus urticae*, the bean mite, *T. ludenii*, and the strawberry mite, *T. lambi*. Of these *T. urticae* is the major pest, and has a level of resistance to the two organo-phosphate miticides currently used in cotton. Most growers apply between 1-3 expensive sprays ($20 - S40/ha) specifically to control mites each season. Mites can often be found in seedling cotton, but as the cotton undergoes a phase of rapid growth in November and December mites usually become scarce until mid-late January when mite numbers again increase.

Irrigated cropping has provided mites and other pests with large areas of highly nutritious food plants in an otherwise semi-arid environment where food plants are normally scarce. In cotton, this situation is worsened by application of sprays which kill beneficial predators as well as pests. This allows large mite populations to develop which then require management to prevent loss of yield from the crop. Evidence from the United States and Zimbabwe has shown that mites can cause yield losses of between 2% and 60% depending on the timing and severity of outbreaks.

Several factors contribute to make mites a difficult pest to manage. Firstly, mites can develop on a wide range of native plants and can heavily infest other crops, such as maize. These can act as sources for mite infestations in cotton, particularly as mite populations on these crops are rarely controlled. Secondly, mites have a short life cycle - generation times can be as short as 7 days in midsummer, with 12-13 days expected under average summer conditions. This means that mite populations can increase rapidly in response to a favourable environment, particularly if predators have been eliminated by sprays for other pests. Thirdly, mites are excellent colonizers - through a process known as arrhenotoky, virgin females which have been blown or have crawled into a cotton crop can produce viable male eggs. Males arising from these eggs can fertilize the female mites, which can then produce both male and female eggs, thereby starting a new colony. Fourthly, it is difficult to assess accurately the level of mite infestation in a cotton field. Apart from their small size which makes them hard to see, mites often tend to be concentrated in 'hotspots' making it difficult to determine population size without prohibitive amounts of sampling. Often they are not found until the damage they cause is obvious, by then the mite population is already well established. Finally, mites normally colonize the underside of leaves, so sprays applied aerially must have systemic or translaminar action to reach mites effectively. This precludes the wide range of potent contact miticides from use in cotton unless they are applied by ground rig.

There is little information on the ecology of mites in cotton. This has hindered the development of control practices and led to the development of a wide folklore concerning the causes of mite upsurges and their control. Red sandy soil, dust, and early sprays of 'hard' chemicals, have all been implicated with outbreaks of mites. While these theories may prove to be true, as yet there is little direct evidence to prove or disprove them.

A project has been initiated at the CSIRO Cotton Research Unit, with funding provided by the Cotton Research Council, to improve our understanding of mite ecology and control.. The aims of the project are:

1. To develop a quick, accurate technique for determining mite abundance and to establish economic action thresholds for mite control.
2. To determine the effects of mites on the yield and fibre quality of different cotton varieties.
3. To study the ecology of mites and identify the sources of mite infestation of cotton crops.
4. To identify and establish the effectiveness of natural enemies of mites in cotton.

During the 1985/86 season we studied the within-field and within-plant distributions of mites, the effects of mites on cotton yield and fibre quality, compared mite levels on Deltapine 90, Deltapine 61 and Siokra, and began studies on the natural enemies of mites.

The within-plant distribution of mites was studied by collecting all of the primary leaves (those leaves arising from the mainstem) from 15 plants each week at each of 5 locations. In the laboratory the number of mite eggs, nymphs, females, and males, and the percentage of the leaf damaged was recorded for each leaf. Preliminary analyses show that mites are predominantly distributed in the uppermost 5-6 nodes. The range of nodes at which mites are present increases as the population increases and the number of mites per leaf correlated well with the level of damage to that leaf. We plan to test whether counts of females can be used to estimate the composition of the rest of the mite population.

To investigate the distribution of mites within fields we used a grid sampling pattern. We sampled 6ha portions of large fields or small fields in their entirety. A plant was sampled every 30 meters down every thirtieth row. At each plant the damage level and the number of female mites was recorded for leaves at the third, sixth and tenth nodes from the terminal. Early analyses showed a useful correlation between the number of mites per leaf at a particular node and the proportion of plants in the crop that had mites at that node. This information will be used in the development of a presence/absence sampling plan. The distribution patterns of mites have yet to be analysed, however, at one location, where cotton was grown adjacent to a heavily mite infested field of maize it was evident that large numbers of mites were being blown or had crawled from the maturing maize into the cotton crop.

The effect of mites on the yield and fibre quality of cotton was studied by comparing cotton plants from within mite 'hotspots' with nearby cotton plants with few mites. The areas sampled were selected carefully to ensure that any differences were due to mites rather than other factors. Mite infestation caused premature opening and subsequent losses of 22-32% of yield in the 'hotspots' (Table 1). Mites caused plants to produce fewer and smaller bolls, in particular bolls that formed earlier in the season were less affected than bolls formed later (Table 2). Analysis of fibre quality data showed that mites had no obvious effect on fibre length, strength , or on the uniformity of fibre length but did cause a substantial reduction in micronaire. Cotton formed later in the season was most affected, probably due to the premature opening of bolls in 'hotspots' (Table 2).We emphasize, however, that these results were obtained by sampling in localized 'hotspots' and any effect on machine harvested yield will be a reflection of the size of the 'hotspots' in relation to the size of the whole field.

A census of mite numbers in an unsprayed block containing plots of Deltapine 61,Deltapine 90 and Siokra showed Siokra to have fewer mites than the normal leaf varieties (Table 3). Other studies also found fewer mites on okra leaf varieties when compared with genetically similar normal leaf varieties (G. Fitt pers. com.). This suggests that the greater insect resistance of okra leaf varieties is due to their reduced leaf area and possibly their less favourable canopy microclimate.

Thrips have often been found in association with mite infestations and observations have confirmed that some thrips from cotton do prey on mites. Only one species has been identified so far, *Scolothrips sexmaculatus*, the six spotted thrips, which was found in cotton late in the season. This species is well known as an effective mite predator in cotton in the United States. There are, however, considerable difficulties in separating immature thrips of different species, which are all 'small and yellow', and this has led to the confusion of species in the past.

In summary, our research shows that mites do cause significant losses of yield and quality in cotton. Work on the within-field and within-plant mite distribution will allow the development of quick accurate techniques for estimating mite numbers which can be used by growers and researchers alike. It is hoped that this study will lead to an improved pest management system minimizing the need for application of miticides.

Table 1. Mean numbers of bolls per metre, boll weights(g) and lint yields (g/m) of cotton from 'hotspots' and adjacent areas with low mites (control) from two locations in the Namoi Valley and one in the Gwydir Valley.

Location		bolls/m	mean boll weight(g)	lint yield (g/m)
1. Namoi	control	102	2.0	204
	hotspot	88	1.7	152
	% loss (hotspot)	14%	15%	25%
2. Namoi	control	144	2.0	294
	hotspot	110	1.8	200
	% loss (hotspot)	23%	10%	32%
3. Gwydir	control	106	1.9	199
	hotspot	93	1.6	154
	% loss (hotspot)	13%	16%	22%

Table 2. Mean weight (g) and micronaire of bolls up to the 60% open bolls crop stage (early) and from 60-100% open bolls stage (late) for bolls picked from 'hotspots' and nearby areas with few mites (controls).

Location	Boll weights(g)		Micronaire		
	Early	Late	Early	Late	Overall
Hotspot	1.88	1.27	3.95	2.40	3.33
Control	2.11	1.69	4.52	3.17	3.98
% Reduction (hotspot)	11%	25%	12%	24%	16%

Table 3. Mean numbers of female mites per leaf on the third, sixth and tenth nodes from the terminal on Siokra, DP90 and DP61 (n = 96 in each case).

Variety	Node 3	Node 6	Node 10
Siokra	1.0	0.8	0.1
DP90	3.4	2.5	0.9
DP61	2.9	2.0	0.7